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PATENT APPLICATION

INVENTOR(S): Laurence E. BAYS; Jalil FADAVI-ARDEKANI; Daniel K. GREENWOOD; Srinivasa GOTTU  
Bahram Ghaffarzadeh KERMANI; Richard J. NIESCIER; Geoffrey L. SMITH; and Walter G. SOTO

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TITLE: DYNAMIC PARTITIONING OF MEMORY BANKS AMONG MULTIPLE AGENTS

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SIR:

Enclosed are the following papers relating to the above-named application for patent:

Specification (including claims and Abstract) - 20 pages

7 Informal sheets of drawing(s)

Assignment and Cover Sheet

Declaration and Power of Attorney

Information Disclosure Statement

CLAIMS AS FILE				
	NO. FILED	NO. EXTRA	RATE	CALCULATIONS
Total Claims	23 - 20 =	3	x \$22 =	\$66
Independent Claims	7 - 3 =	4	x \$82 =	\$328
Multiple Dependent Claim(s), if applicable			\$270 =	\$0
Basic Fee				\$790
TOTAL FEE:				\$1184

Please file the application and charge **Lucent Technologies Deposit Account No. 12-2325** the amount of **\$1184**, to cover the filing fee. Duplicate copies of this letter are enclosed. In the event of non-payment or improper payment of a required fee, the Commissioner is authorized to charge or to credit **Deposit Account No. 12-2325** as required to correct the error.

Please address all correspondence to **FARKAS & MANELLI, PLLC, 2000 M Street, N.W. 7th Floor, Washington, DC 20036-3307**, and all telephone calls to William H. Bollman at his Washington, DC local number of (202) 261-1020.

Respectfully submitted,



William H. Bollman

Reg. No.: 36,457

Attorney for Applicant(s)

Date: July 22, 1998

Farkas & Manelli, PLLC  
2000 M Street, N.W. 7th Floor  
Washington, DC 20036-3307  
(202) 261-1000

# APPLICATION UNDER UNITED STATES PATENT LAWS

Invention: **DYNAMIC PARTITIONING OF MEMORY BANKS  
AMONG MULTIPLE AGENTS**

Inventors: Bahram Ghaffarzadeh KERMANI;  
Laurence E. BAYS;  
Jalil FADAVI-ARDEKANI;  
Daniel K. GREENWOOD;  
Srinivasa GUTTA;  
Richard J. NIESCIER;  
Geoffrey L. SMITH; and  
Walter G. SOTO

Farkas & Manelli P.L.L.C.  
2000 M Street, N.W.  
7<sup>th</sup> Floor  
Washington, D.C. 20036-3307  
Attorneys  
Telephone: (202) 261-1000

This is a:

- Provisional Application
- Regular Utility Application
- Continuing Application
- PCT National Phase Application
- Design Application
- Reissue Application
- Plant Application

## SPECIFICATION

# DYNAMIC PARTITIONING OF MEMORY BANKS AMONG MULTIPLE AGENTS

This application claims priority from U.S. Provisional  
5 Application No. 60/065,855 entitled "Multipurpose Digital Signal  
Processing System" filed on November 14, 1997, the specification of  
which is hereby expressly incorporated herein by reference.

## BACKGROUND OF THE INVENTION

10

### 1. Field of the Invention

This invention relates generally to the shared usage of  
memory by a plurality of agents, i.e., processors. In particular, in one  
aspect it relates to the efficient use of shared synchronous memory by a  
15 plurality of agents, and in another aspect it relates to the flexible partitioning  
of shared memory between a plurality of agents.

### 2. Background of Related Art

With the ever-increasing speeds of today's processors,  
20 memory designs have attempted to meet the required speed  
requirements. For instance, synchronous memory such as synchronous  
static random access memory (SSRAM) and synchronous dynamic  
random access memory (SDRAM) are commonly available synchronous  
types of memory.

25 Synchronous memory technology is currently used in a wide  
variety of applications to close the gap between the needs of high-speed  
processors and the access time of asynchronous memory such as  
dynamic random access memory (DRAM). Synchronous memory, e.g.,  
SDRAM technology, combines industry advances in fast dynamic random  
30 access memory (DRAM) with a high-speed interface.

Functionally, an SDRAM resembles a conventional DRAM, i.e., it is dynamic and must be refreshed. However, the SDRAM architecture has improvements over standard DRAMs. For instance, an SDRAM uses internal pipelining to improve throughput and on-chip interleaving between separate memory banks to eliminate gaps in output data.

The idea of using a SDRAM synchronously (as opposed to using a DRAM asynchronously) emerged in light of increasing data transfer demands of high-end processors. SDRAM circuit designs are based on state machine operation instead of being level/pulse width driven as in conventional asynchronous memory devices. Instead, the inputs are latched by the system clock. Since all timing is based on the same synchronous clock, designers can achieve better specification margins. Moreover, since the SDRAM access is programmable, designers can improve bus utilization because the processor can be synchronized to the SDRAM output.

The core of an SDRAM device is a standard DRAM with the important addition of synchronous control logic. By synchronizing all address, data and control signals with a single clock signal, SDRAM technology enhances performance, simplifies design and provides faster data transfer.

Similar advantage hold for other types of synchronous memory, e.g., SSRAM or even synchronous read only memory.

Synchronous memory requires a clock signal from the accessing agent to allow fully synchronous operation with respect to the accessing agent. If more than one agent is given access to a shared synchronous memory, each agent must conventionally supply its own clock signal to the synchronous memory. Unfortunately, the clock signals from separate agents are not conventionally synchronous or in phase with one another. Therefore, if a synchronous memory were to be shared

among a plurality of agents, delays or wait states would be required to allow an error-free transition between access by the first agent having a first synchronous memory access clock signal and a subsequent access by another agent having a different synchronous memory access clock signal.

Some synchronous memory devices have the capability to provide burst input/output (I/O), particularly for the optimization of cache memory fills at the system frequency. Advanced features such as programmable burst mode and burst length improve memory system performance and flexibility in conventional synchronous memories, and eliminate the need to insert otherwise unnecessary wait states, e.g., dormant clock cycles, between individual accesses in the burst.

Conventional SDRAM devices include independent, fixed memory sections that can be accessed individually or in an interleaved fashion. For instance, two independent banks in an SDRAM device allow that device to have two different rows active at the same time. This means that data can be read from or written to one bank while the other bank is being precharged. The setup normally associated with precharging and activating a row can be hidden by interleaving the bank accesses.

There are limitations to conventional system designs using synchronous memory. For instance, wait states are inevitable and necessary when the shared synchronous memory adjusts for access by a different agent having a different clock signal.

For instance, Fig. 5 shows a conventional circuit for allowing, e.g., three agents **502-506** to access a shared synchronous memory block **508**. Each agent **502-506** may be a suitable processor, e.g., a microprocessor, a microcontroller, or a digital signal processor (DSP). As shown in Fig. 5, the processors **502-506** provide read and/or write access to the shared synchronous memory block **508**.

As may be appreciated, memory accesses by the separate agents **502-506** would clash unless they are arbitrated to allow only one agent to access the synchronous memory **508** at any one time. Thus, selection logic (i.e., an arbitrator **512**) is conventionally provided to control  
5 a multiplexer **510**, which selects the appropriate address for presentation to the synchronous memory **508**, data and control (ADC) signals and clock signal from a current 'owner' of the busses. Typically, the agents **502-506** are assigned a hierarchy in which the highest priority agent will own the busses to the synchronous memory **508** and block out accesses  
10 by the other agents until finished.

Unfortunately, in such a system as is shown in Fig. 6, if the relative speeds of the agents **502-506** vary and/or the relative phase of the clock signals from each of the respective agents **502-506** varies with respect to one another, accesses to the synchronous memory **508** may  
15 necessarily include wait states. Wait states decrease the overall speed of accesses to the synchronous memory **508** and result in decreased performance.

Moreover, as background to another aspect of the invention, a plurality of separate memory systems **600** may be provided as shown in  
20 Fig. 6, using one or more arbitrators **612** to authorize access to the respective separate memory blocks **508a**, **508b** by the separate agents. However, the memory block **508a** must be sized with respect to the maximum required amount of memory by the pre-defined groups of accessing agents **602-606**, and the memory block **508b** must be sized  
25 with respect to the maximum required amount of memory by the pre-defined groups of accessing agents **622-626**. However, in practice, the synchronous memory blocks **508a**, **508b** are less than fully utilized, thus wasting memory. Moreover, if a particular use or application of the device uses one agent but not others, the memory pre-defined for use by the  
30 unused agent is wasted.

There is thus a need for synchronous memory systems which in one aspect allow efficient use of synchronous memory resources, e.g., by reducing the use of wait states. Moreover, there is also a need for memory systems which in another aspect allow efficient usage of shared 5 memory with respect to adjusting for accesses by a plurality of accessing agents.

## **SUMMARY OF THE INVENTION**

In accordance with the principles of the present invention, a 10 multiple agent system using shared memory comprises a memory including a plurality of memory banks. A first agent is adapted to access a first memory portion including a first number of the memory banks. A second agent is adapted to access a second memory portion including a second number of the memory banks, wherein the first number and the 15 second number are variable.

In another aspect, the present invention provides a system comprising a plurality of agents. A shared memory block is accessible by each of the agents, the shared memory block including a plurality of memory banks. A register is adapted to partition the shared memory 20 block into a plurality of partitions, each of the plurality of partitions being accessible by a unique group of the agents.

In yet another aspect for providing a system with access to shared memory, a first agent provides a memory access clock signal to allow the first agent to access the shared memory. A second agent using 25 the memory access clock signal accesses the shared memory in synchronism with the access by the first agent to the shared memory.

A method of synchronizing access from a plurality of agents to shared memory in accordance with the principles of the present invention comprises providing a memory access clock signal. The shared 30 memory is firstly accessed from a first agent based on the memory access

clock signal. The shared memory is secondly accessed from a second agent based on the memory access clock signal. Wherein, the second access follows the first access without a wait state therebetween.

In a method of partitioning a shared memory in accordance  
5 with another aspect of the present invention, a configuration register is set to partition the shared memory into a first plurality of memory banks and a second plurality of memory banks. The first plurality of memory banks is accessed from a first agent, and a second plurality of memory banks is accessed from a second agent. Then, the shared memory is re-  
10 partitioned on-the-fly.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

Features and advantages of the present invention will become apparent to those skilled in the art from the following description  
15 with reference to the drawings, in which:

Fig. 1 shows a first embodiment of a first aspect of the present invention wherein a memory system has one or more agents which utilize a clock signal from a super agent to synchronize clock signal access timing to the shared synchronous memory.  
20 Fig. 2 shows a second embodiment of the first aspect of the present invention wherein a memory system has one or more agents which utilize a system clock signal to synchronize clock signal access timing to the shared synchronous memory.

Fig. 3 shows another aspect of the present invention  
25 wherein a shared memory is configurably partitioned to assign a pre-defined number of memory banks to each accessing agent.

Fig. 4A shows one embodiment of the partitionable memory system shown in Fig. 3.

Fig. 4B shows another embodiment of the partitionable  
30 memory system shown in Fig. 3.

Fig. 5 shows a plurality of agents accessing a synchronous memory block in accordance with a conventional memory system.

Fig. 6 shows a plurality of agents accessing a plurality of synchronous memory blocks in accordance with another conventional  
5 memory system.

## DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

Fig. 1 shows a first embodiment of a first aspect of the present invention wherein a multiple agent system has one or more  
10 agents which utilize a clock signal from a super agent to synchronize clock signal access timing to the shared synchronous memory.

In particular, a synchronous memory block **110** is accessed by a plurality of agents **102-106** as shown in Fig. 1. Although three agents **102-106** are shown in Fig. 1, the present invention relates to  
15 multiple agent systems having any number of agents accessing shared memory.

An appropriately sized multiplexer (MUX) **108** forms a switch which allows any one of the multiple agents **102-106** to access the shared synchronous memory **110**. The relevant busses for each agent **102-106**  
20 include the address, data and control (ADC) busses and a clock signal.

The MUX **108** is controlled by selecting logic, i.e., an arbitrator **112**. The arbitrator **112** is provided with respective memory request signals **130-134** from each of the accessing agents **102-106**, and based on a pre-determined hierarchy, allows one of the agents **102-106** to  
25 access the shared synchronous memory **110**. The requesting agents **102-106** are informed of a granting of the busses to the shared synchronous memory **110** using an acknowledge signal from the arbitrator **112** back to the successful requesting agent.

Importantly, the respective clock signals **140**, **140a** and  
30 **140b** from the multiple agents **102-106** are synchronized with one another

to reduce and/or eliminate the need for wait states in accessing the shared synchronous memory 110, particularly when switching between accesses from the different agents 102 to 106. Thus, not only does the memory access speed from each of the agents 102-106 become the  
5 same with respect to each of the different agents 102-106, but the phase of the respective clock signal from each of the agents 102-106 becomes the same with respect to one another.

In the embodiment shown in Fig. 1, one agent is pre-determined to be a 'super agent', e.g., 102, and the remaining agents 104 and 106 are thus considered to be 'non-super agents' or simply 'agents'.  
10 A difference between a super agent and a non-super agent as the term is used herein is the way in which communication is made with the shared synchronous memory 110. Typically, a super agent does not allow any clock cycles to be wasted, i.e., wait states to be inserted, for negotiation or  
15 arbitration with the shared synchronous memory 110. Once the memory request signal is submitted by the super agent, the access to the shared synchronous memory 110 follows. On the other hand, a non-super agent has the capability of waiting for an acknowledge signal after submitting a memory request signal.

20 The super agent 102 is responsible for generating a clock signal 140 which is switched to the shared synchronous memory 110 through the MUX 108 when the super agent 102 is accessing the shared synchronous memory 110. Preferably, but not necessarily, the super agent 102 will be that agent which most frequently accesses the shared  
25 synchronous memory 110 from among the multiple agents 102-106, or is otherwise assigned the highest priority for access to the shared synchronous memory 110.

As shown in Fig. 1, the clock signal 140 from the super agent 102 is input to the remaining or non-super agents 104-106. The  
30 remaining agents 104-106 output a representation of the same clock

signal 140 for their own accesses to the shared synchronous memory 110, as shown by signals 140a and 140b. The non-super agents 104, 106 synchronize the respective address, data and control bus interfaces within the non-super agents 104, 106 to the input clock signal 140.

5 Accordingly, all memory accesses to the shared synchronous memory 110, whether originated from the super agent 102 or any other agent 104, 106, will be synchronized. Thus, wait states are not necessary between accesses to the shared synchronous memory 110 by the various agents 102-106.

10 The non-super agents 104, 106 which receive the clock signal 140 from the super agent 102 are free to use the clock signal 140 for other purposes as well as for accessing the shared synchronous memory 110. For instance, the clock signal 140 may be used as a general processor clock in place of an external crystal oscillator.

15 Fig. 2 shows a second embodiment of the first aspect of the present invention wherein all agents 102a, 104 and 106 are non-super agents using a shared system clock signal 150 to synchronize clock signal access timing to the shared synchronous memory 110.

20 In particular, the shared synchronous memory 110 may be conventional and is as described and shown with respect to the embodiment of Fig. 1. Moreover, the MUX 108, arbitrator 112 and non-super agents 104, 106 are as described and shown with respect to Fig. 1. In this embodiment, however, the super-agent 102 shown in Fig. 1 is replaced with a non-super agent 102a.

25 All three agents 102-106 receive a system level clock signal 150 to which respective address, data and control busses as well as respective memory access clock signals 240a-240c are synchronized. Thus, the clock signal 240d provided to the shared synchronous memory 110 is synchronized, e.g., has the same frequency, duty cycle and/or 30 phase with respect to the clock signals 240a, 240b or 240c from any of

the agents **102a**, **104** and **106**. This reduces or eliminates altogether the need for wait states in memory accesses from any of the agents **102-106**.

In a variation of the embodiment shown in Fig. 2, the clock signals **240a**, **240b** and **240c** may be eliminated and the system clock signal **150** may be directly provided to the shared synchronous memory **110**, with the address, data and control busses of all agents **102a**, **104**, **106** being appropriately timed.

The super agent **102** may have any arbitrary clock signal **140** for accessing the shared synchronous memory **110**. However, the non-super agents **104**, **106** must be able to adopt the clock signal **140** from the super agent **102** for use in their respective accesses to the shared synchronous memory **110**. Moreover, for each partition or block of sharedly accessed memory **110**, preferably only one super agent **102** is allowed, with any or all other agents **104**, **106** for that partition being non-super agents which adopt the memory access clock signal **140** from the super agent **102**.

Thus, according to the first aspect of the present invention, the memory clock signals from a plurality of agents are synchronized with one another to minimize or eliminate altogether the delays, i.e., wait states, caused in accessing shared synchronous memory.

According to another aspect of the present invention shown in Figs. 3, 4A and 4B, a shared memory block is partitioned for use by individual ones or groups of agents.

For instance, Fig. 3 shows the other aspect of the present invention wherein a shared memory is configurably partitioned to assign a pre-defined number of memory banks to each accessing agent or group of agents. Although Fig. 3 shows synchronous memory **310**, this aspect of the present invention relates equally to asynchronous memory.

The embodiment of Fig. 3 is shown with respect to two groups of accessing agents, i.e., a first group of shared memory

accessing agents **340** including a super agent **302** and non-super agents **304** and **306**, and a second group of shared memory accessing agents **342** including another super agent **312** and two more non-super agents **314**, **316**. Although the embodiment of Fig. 3 is shown with respect to two agent groups **340**, **342**, the present invention is equally applicable to more than two groups of accessing agents to a shared memory block. Moreover, although the agent groups **340**, **342** are shown with an equal number of agents, the present invention is equally applicable to groups of accessing agents having any number of agents.

10           In accordance with the second aspect of the present invention, the memory block **310** is configurably partitioned into a corresponding number of partitions **310a**, **310b**. Although the embodiment is shown with two partitions **310a**, **310b**, the invention is equally applicable to any number of partitions. Preferably, the number of partitions will equal the number of agent groups.

15           The separate agent groups **340**, **342** access respectively partitioned portions of the shared memory **310**. The partitions **310a**, **310b** may be any size, from zero to the entire memory block **310**, as set in a configuration register **360**.

20           In this aspect, the assignment of an available memory block **310** is flexible, allowing any or all of the memory block **310** to be assigned to any of the agent groups **340**, **342**. With the configurability as disclosed, the user can change the memory configuration on-the-fly, by executing certain instructions in the code to change the value in the configuration register **360**.

25           The configuration register **360** can be written to by any of the agents **302**, **304**, **306**, **312**, **314** and **316**. In the disclosed embodiment, the value written to the configuration register **360** corresponds to the length of the first partition **310a**, any and all remaining 30 memory banks being assigned to the second partition. Of course, multiple

words or registers may be implemented within the configuration register **360** to accommodate more than two configurable partitions in the shared memory block **310** in accordance with the principles of the present invention.

5 It is preferred (but not required) that the memory block **310** be partitionable into contiguous parts. For instance, if the configuration register **360** comprises one, four-bit register, it may adequately represent partitions between any of up to sixteen memory banks.

For example, assume for the purpose of explanation that  
10 there are fourteen memory banks in the memory block **310**. If any of the  
agents **302**, **304**, **306**, **312**, **314** or **316** writes the value '9' (1001B) to the  
configuration register **360**, this would be interpreted by the arbitrator **312**  
15 to partition the memory block **310** such that the first nine individual  
memory banks are to be assigned to the first agent group **340**, and that  
the remaining five individual memory banks are to be assigned to the  
second agent group **342**. The four bits of the configuration register **360**  
20 are then decoded by the arbitrator **412a** to provide appropriate control  
signals to a first MUX **308** to select or deselect the requesting or winning  
agent in the first agent group **340** and to the second MUX **318** to select or  
deselect the requesting or winning agent in the second agent group **342**.  
Because the memory block **410** is partitioned, both agent groups **340**, **342**  
25 may access the respective partition **310a**, **310b** without conflict.

To avoid configuration conflicts, it may be preferable to allow  
only one or a select group of agents to have write access to the  
25 configuration register **360**.

In a multiple agent system, one shared memory block is  
often provided for use by all agents in the system. For various reasons,  
e.g., vastly differing application programs in each of the agents for any  
one user, a fixed amount of memory for each agent in the system is  
30 inefficient. For instance, if one user implements code in only one of two

available DSPs in an integrated circuit comprising a memory accessing system in accordance with the aspects of the present invention, then that user will have minimal if any memory requirement for the second DSP. In that case, it might be desirable to assign or partition all available shared 5 memory to the first DSP and no memory to the second DSP.

According to this aspect of the present invention, the assignment of individual memory banks **1** to **14** as shown in Figs. 4A and 4B is performed in a flexible manner. Of course, although the embodiments of Figs. 4A and 4B are shown with respect to fourteen 10 individual memory banks, the invention is equally applicable to shared memory blocks having any number of individual memory banks.

Preferably, the partitions in a shared memory block will be placed with ends thereof between individual memory banks comprising the memory block, e.g., between any of the memory banks **1** to **14** as 15 shown in Fig. 4A. The partitioning of a shared memory block with respect to a plurality of agents in accordance with this aspect of the present invention may be performed with synchronous and/or asynchronous memory. Thus, Figs. 4A and 4B show a memory bank **410** comprising individual memory banks **1** to **14** of either synchronous (e.g., SDRAM) 20 memory or asynchronous (e.g., DRAM) memory.

Fig. 4B shows another embodiment of the partitionable memory system shown in Fig. 3. In this embodiment, each memory bank **1** to **14** is configurably selected by any accessing agent, e.g., agent #1 or agent #2, by suitable multiplexers **401** to **414** which are individually 25 controlled by selecting logic (arbitrator) **412b**. The arbitrator **412b** implements partitions in the memory block **410** set in the configuration register **460b**.

An application example of this aspect of the present invention is as follows. Assume that there are two agents in a system, 30 where each agent is a DSP. Initially, the first DSP may be running a

modem application program requiring at least seven memory banks, and the second DSP may be running a medium quality audio session requiring at least seven memory banks. In this case, the configuration register may be set to a '7' (0111B) to assign the first seven memory banks **1-7** to the 5 first DSP, and the remaining seven memory banks **8-14** to the second DSP. Then, at a later point in time, the user may run a high quality audio session at the second DSP which requires 12 memory banks. Either the first or second DSP can adjust the setting in the configuration register **460** to appropriate more memory banks to the second DSP, albeit at the 10 expense of the size of the memory partition for the first DSP. For instance, in this case, a value of '2' (0010B) may be written to the configuration register **460** to assign two memory banks **1, 2** to the first DSP leaving the remaining twelve memory banks **3-14** in the second partition of the memory block for use by the second DSP. Conversely, the 15 user may at another point in time wish to run a higher baud rate modem program on the first DSP requiring a larger amount of memory. In this case, the configuration register may be written to, e.g., to assign eleven memory banks **1-11** to the first DSP leaving only the remaining three memory banks **12-14** for use by the second DSP.

20 While the invention has been described with reference to the exemplary embodiments thereof, those skilled in the art will be able to make various modifications to the described embodiments of the invention without departing from the true spirit and scope of the invention.

## CLAIMS

What is claimed is:

1. A system comprising:
  - 5 a memory including a plurality of memory banks;
  - a first agent adapted to access a first memory portion including a first number of said plurality of memory banks; and
  - 10 a second agent adapted to access a second memory portion including a second number of said plurality of memory banks; said first number and said second number being variable.
2. The system according to claim 1, further comprising:
  - 15 a register to set at least one of said first number and said second number.
3. The system according to claim 1, wherein:
  - 20 said register is adapted to be set by either one of said first agent and said second agent.
4. The system according to claim 1, wherein:
  - 25 a value set in said register is adapted to correspond to said first number of said plurality of memory banks.
5. The system according to claim 1, wherein:
  - 30 said second number is a remainder of said plurality of said memory banks after said first number of said plurality of memory banks.
6. The system according to claim 1, wherein:
  - 35 said first agent is a first digital signal processor; and
  - 30 said second agent is a second digital signal processor.

7. A system comprising:  
a plurality of agents;  
a shared memory block accessible by each of said plurality of agents, said shared memory block including a plurality of memory banks;  
a register adapted to partition said shared memory block into a plurality of partitions, each of said plurality of partitions being accessible by a unique group of said plurality of agents.

10 8. The system according to claim 7, wherein:  
said register is setable by at least one of said plurality of agents.

15 9. The system according to claim 7, wherein:  
said plurality of partitions each comprise an integer number of said plurality of memory banks.

20 10. The system according to claim 1, wherein:  
said memory is synchronous memory.

11. The system according to claim 1, wherein:  
said memory is asynchronous memory.

25 12. The system according to claim 10, wherein:  
said synchronous memory is synchronous dynamic random access memory.

13. A system for providing access to shared memory, said system comprising:

a first agent to provide a memory access clock signal to allow said first agent to access said shared memory; and

5 a second agent using said memory access clock signal to access to said shared memory in synchronism with said access by said first agent to said shared memory.

14. The system for providing access to shared memory  
10 according to claim 13, wherein:

said shared memory block services in turn said first agent and said second agent without a wait state therebetween.

15. The system for providing access to shared memory  
15 according to claim 13, wherein:

said shared memory block is partitioned such that said first agent has access to a first partition of said shared memory block; and

said second agent has access to a second partition of said shared memory block.

20 16. The system for providing access to shared memory according to claim 13, wherein:

said first agent is a first digital signal processor; and

said second agent is a second digital signal processor.

25

17. A method of synchronizing access from a plurality of agents to shared memory, comprising:

providing a memory access clock signal;

firstly accessing said shared memory from a first agent

5 based on said memory access clock signal;

secondly accessing said shared memory from a second agent based on said memory access clock signal;

wherein said step of secondly accessing said shared memory follows said step of firstly accessing without a wait state  
10 therebetween.

18. The method of synchronizing access from a plurality of agents to shared memory according to claim 17, further comprising:

regenerating in said second agent said memory access

15 clock signal.

19. The method of synchronizing access from a plurality of agents to shared memory according to claim 17, wherein:

20 said first agent provides said memory access clock signal.

20. A method of partitioning a shared memory, comprising:

setting a configuration register to partition said shared memory into a first plurality of memory banks and a second plurality of memory banks;

25 accessing said first plurality of memory banks from a first agent;

accessing said second plurality of memory banks from a second agent; and

re-partitioning said shared memory on-the-fly.

30

21. The method of partitioning a shared memory according to claim 20, wherein:

    said step of re-partitioning is performed from said first agent.

5           22. Apparatus for synchronizing access from a plurality of agents to shared memory, said apparatus comprising:

    means for providing a memory access clock signal;

10           means for firstly accessing said shared memory from a first agent based on said memory access clock signal;

15           means for secondly accessing said shared memory from a second agent based on said memory access clock signal;

    wherein said means for second accessing accesses said shared memory without a wait state after said means for firstly accessing said shared memory accesses said shared memory.

15

23. Apparatus for partitioning a shared memory, said apparatus comprising:

    means for setting a configuration register to partition said shared memory into a first plurality of memory banks and a second plurality of memory banks;

20           means for accessing said first plurality of memory banks from a first agent;

    means for accessing said second plurality of memory banks from a second agent; and

25

    means for re-partitioning said shared memory on-the-fly.

## ABSTRACT

A multiple agent system providing each of a plurality of agents, e.g., processors, to access a shared synchronous or asynchronous memory. In the case of synchronous memory, the clock signal from a super agent selected from among the plurality of agents provides a memory access clock signal to the other agents accessing the same shared memory. The other agents synchronize their respective address, data and control busses to those of the super agent, and output a representation of the same clock signal to the shared memory. In another aspect of the present invention, the shared memory is partitioned for use from among a plurality of groups of agents, each agent group comprising one or more agents. Any one of the agents may update a configuration register to flexibly reconfigure the amount of shared memory available to the agents as necessary.

15

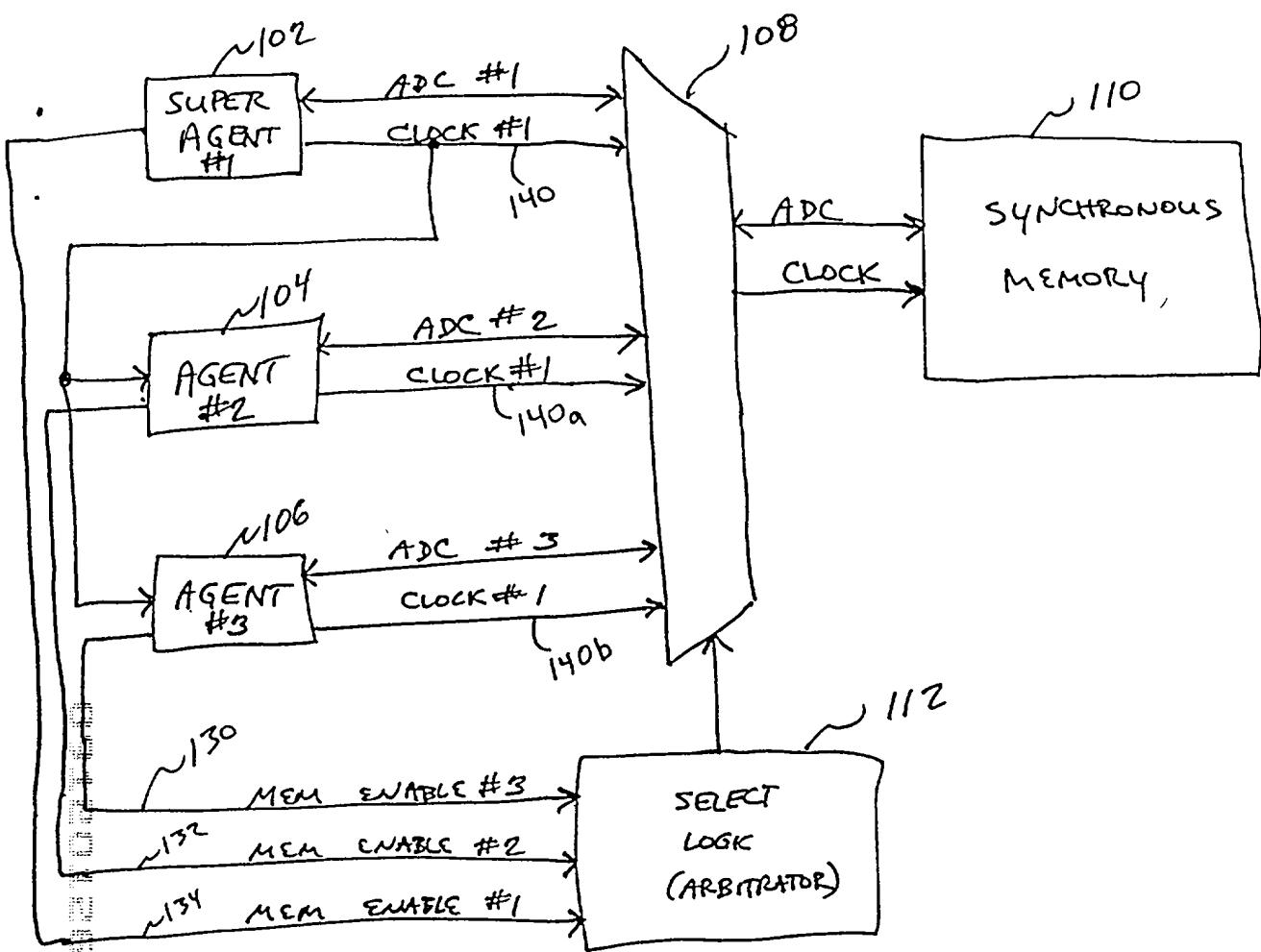


FIG. 1

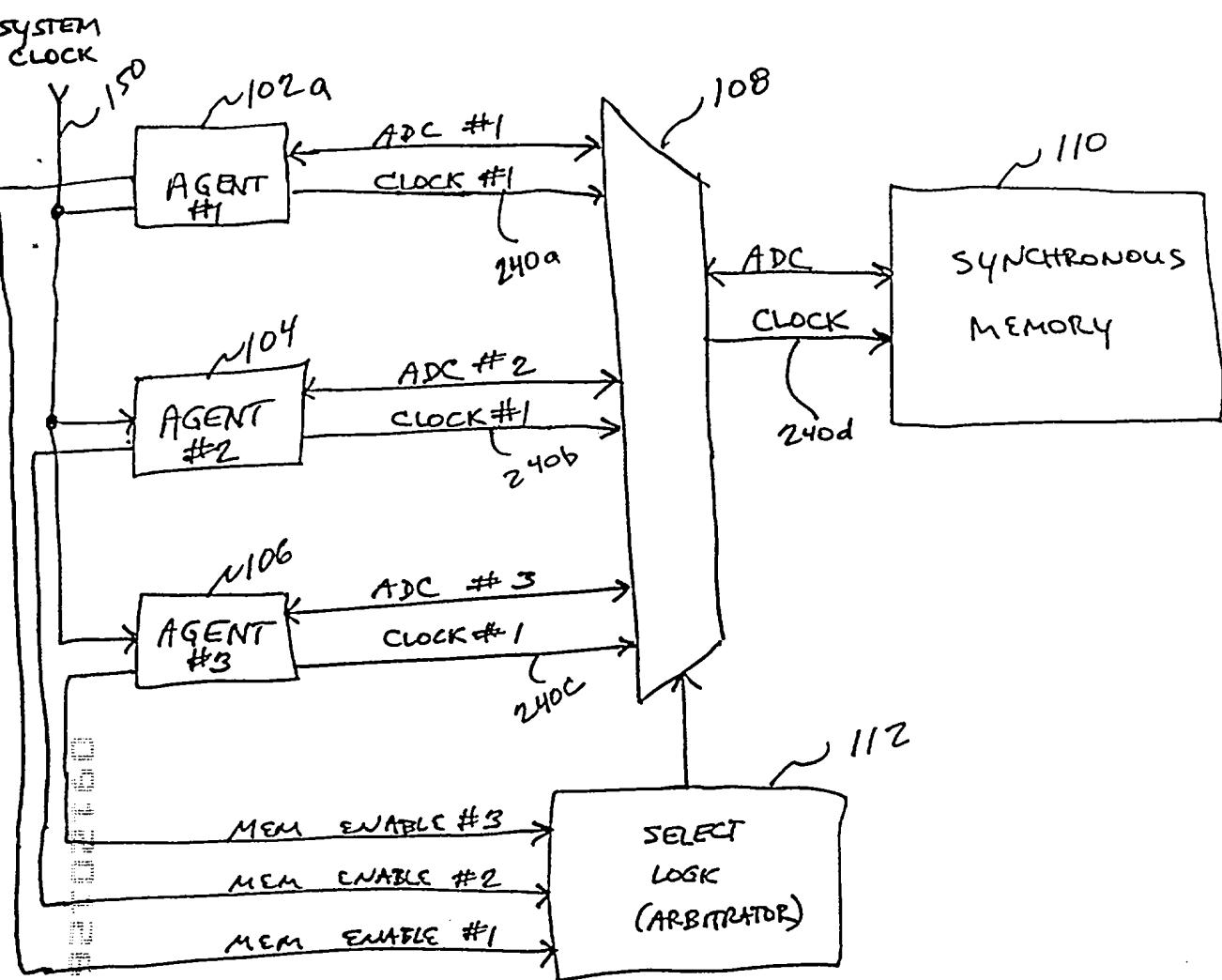
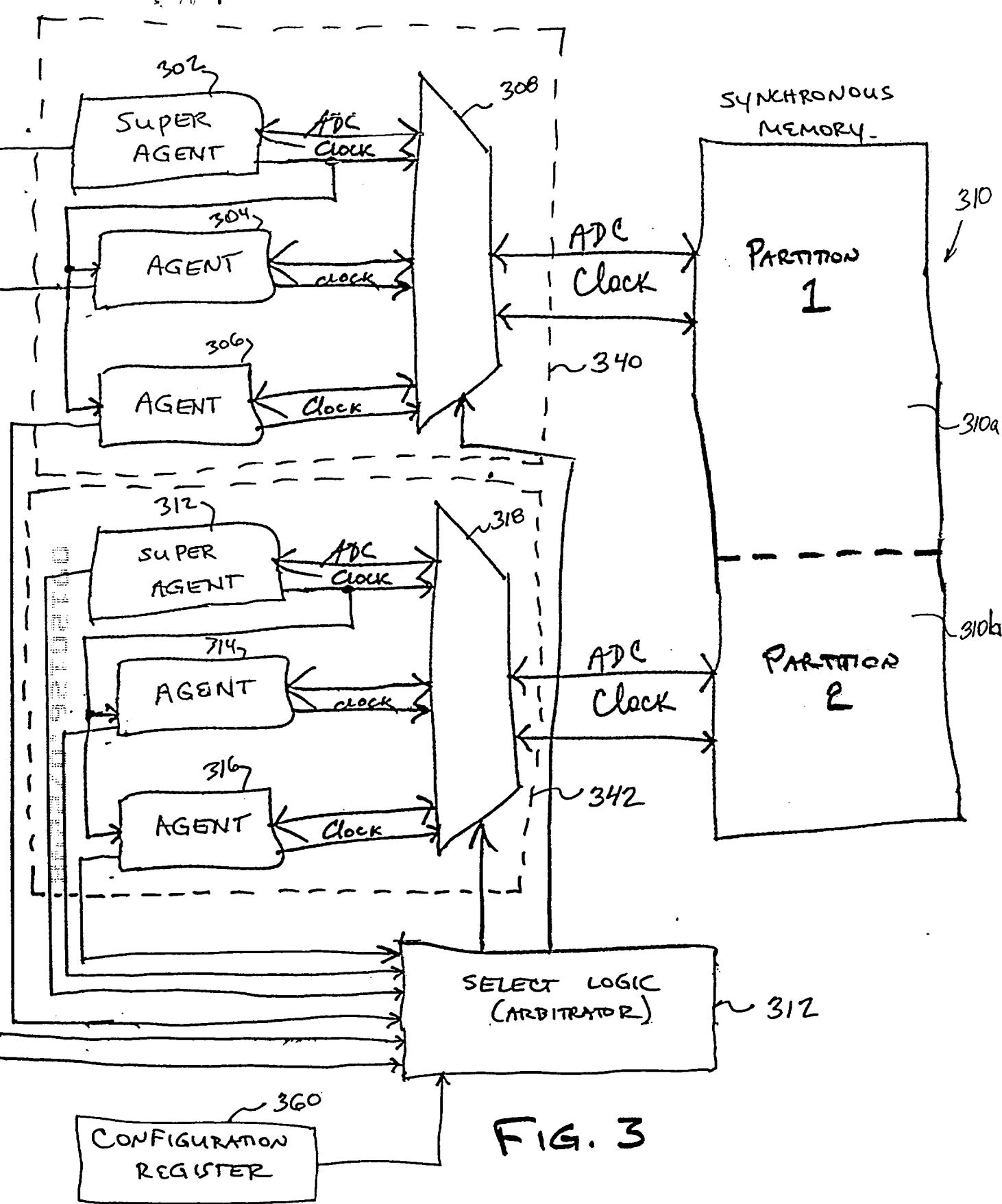


FIG. 2



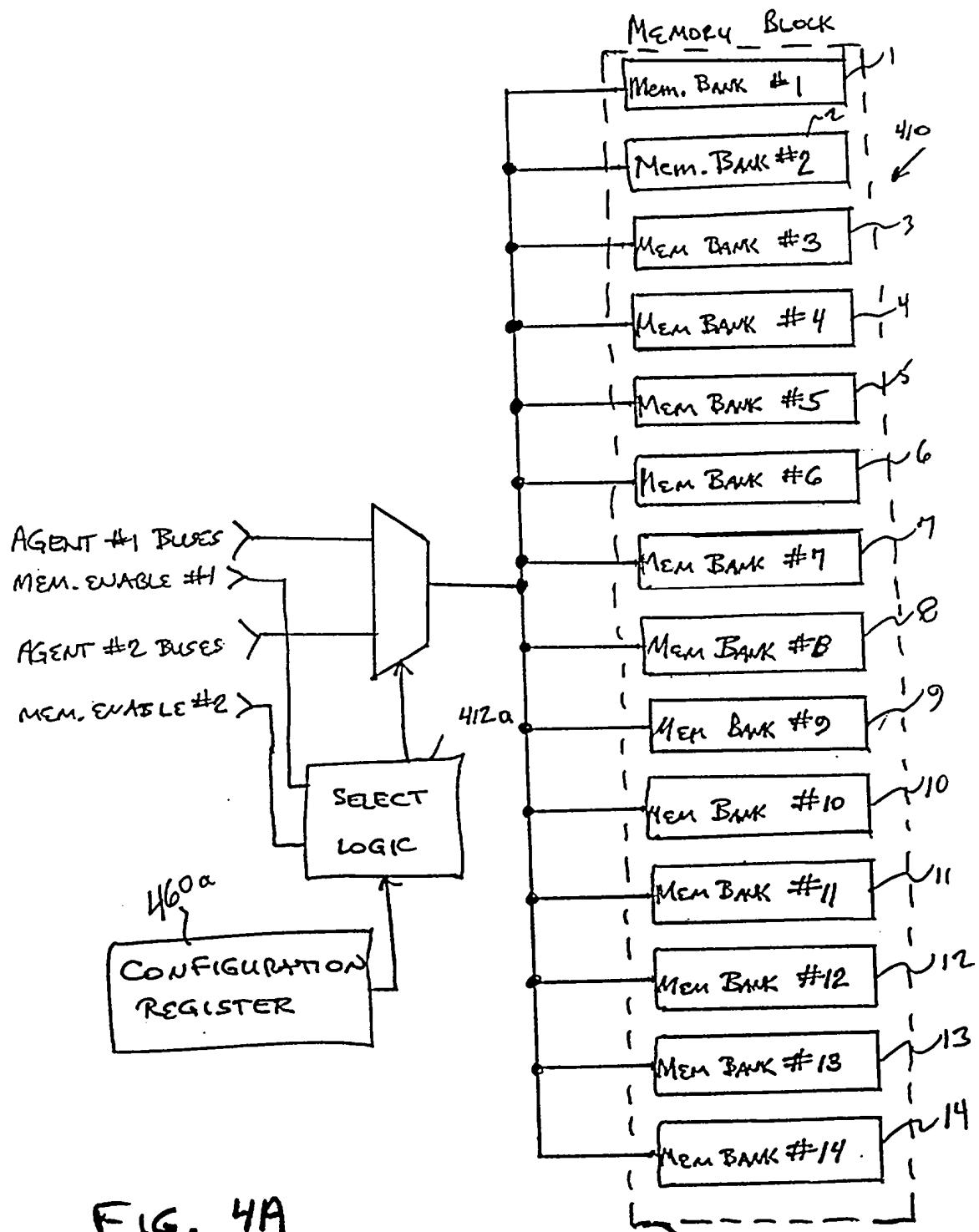


FIG. 4A

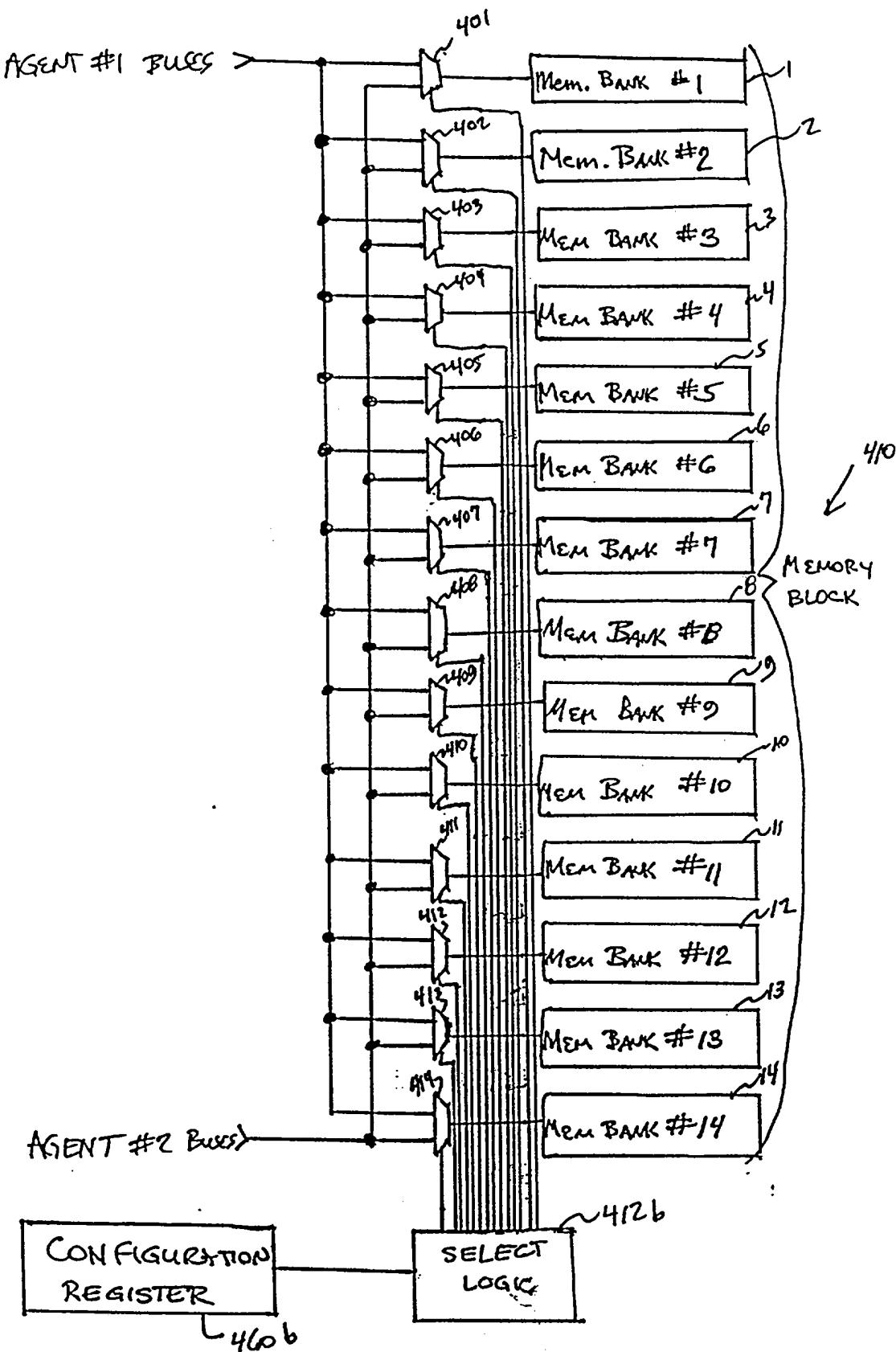


FIG. 4B

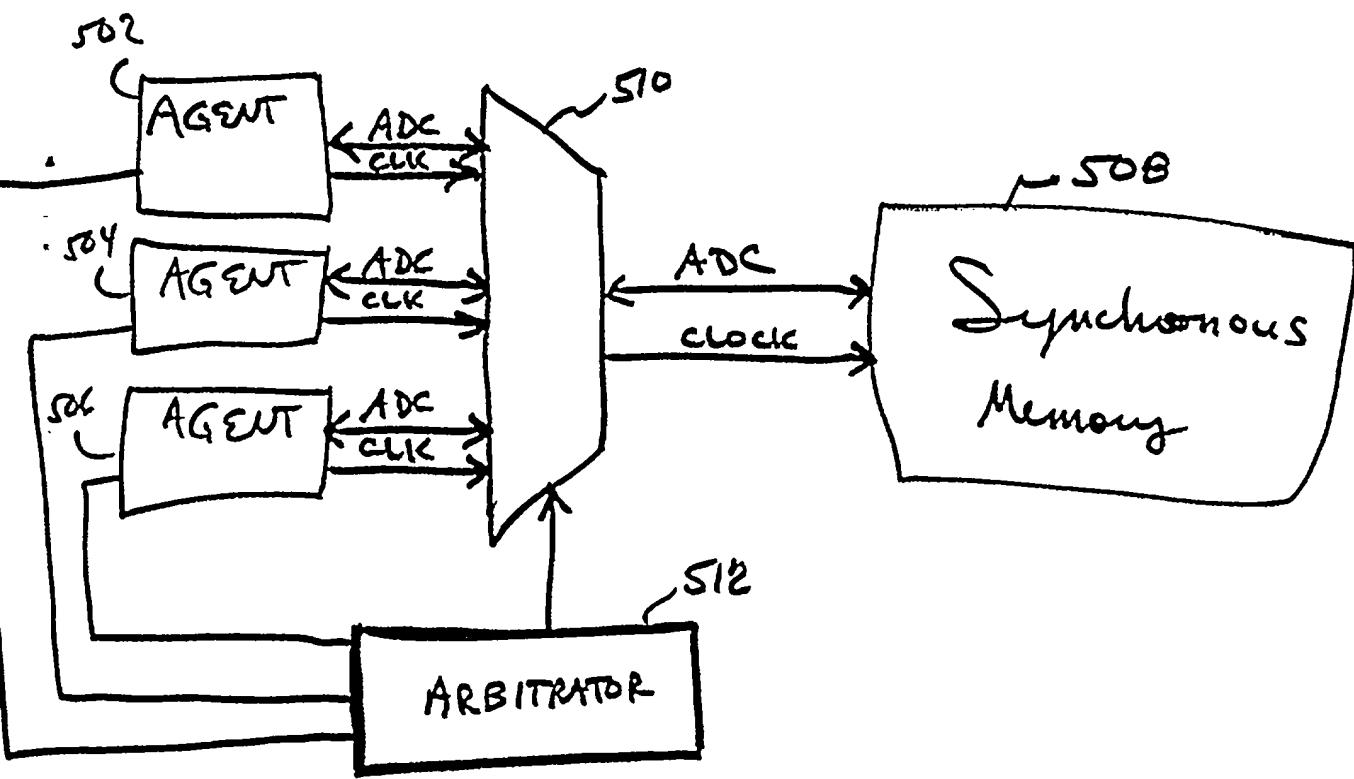
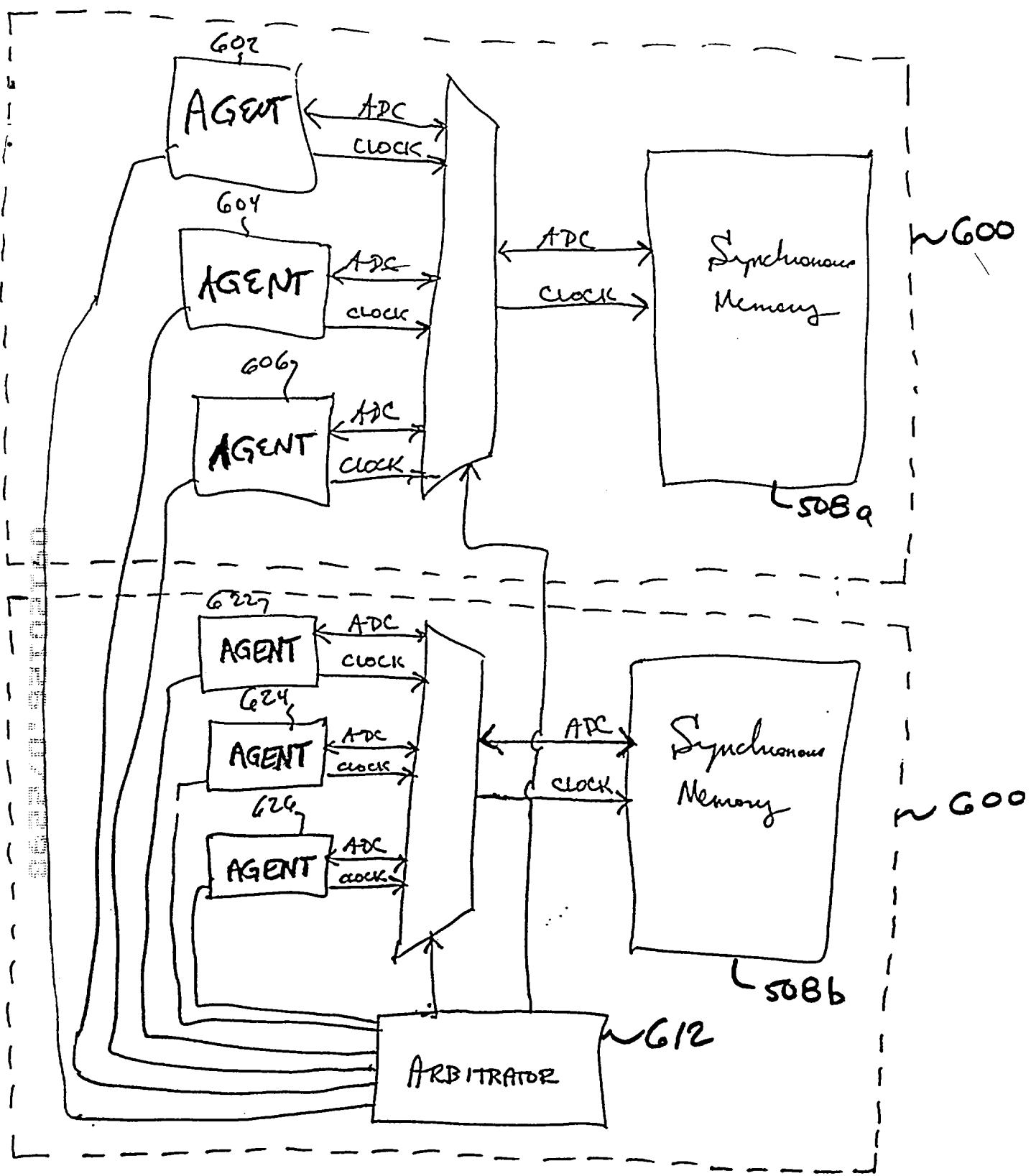


FIG. 5

PRIOR ART



PRIOR ART  
FIG. 6

BAYS (770)

IN THE UNITED STATES  
PATENT AND TRADEMARK OFFICE

## Declaration and Power of Attorney

As the below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **DYNAMIC PARTITIONING OF MEMORY BANKS AMONG MULTIPLE AGENTS**, the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment, if any, specifically referred to in this oath or declaration.

I acknowledge the duty to disclose all information known to me which is material to patentability as defined in Title 37, Code of Federal Regulations, 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

None

I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

U.S. Provisional Appl. No. 60/065,855  
entitled "Multipurpose Digital Signal Processing System"  
filed November 14, 1997

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

BAYS (770)

I hereby appoint the following attorneys with full power of substitution and revocation, to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent and Trademark Office connected therewith:

Steven R. Bartholomew	(Reg. No. 34771)
Lester H. Birnbaum	(Reg. No. 25830)
Richard J. Botos	(Reg. No. 32016)
Jeffery J. Brosemer	(Reg. No. 36096)
Kenneth M. Brown	(Reg. No. 37590)
James A. DiGiorgio	(Reg. No. 36980)
Donald P. Dinella	(Reg. No. 39961)
Guy H. Eriksen	(Reg. No. P-41736)
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Julio A. Garceran	(Reg. No. 37138)
Mony R. Ghose	(Reg. No. 38159)
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Anthony Grillo	(Reg. No. 36535)
Stephen M. Gurey	(Reg. No. 27336)
John M. Harman	(Reg. No. 38173)
Donald E. Hayes Jr.	(Reg. No. 33245)
John W. Hayes	(Reg. No. 33900)
Mark A. Kurisko	(Reg. No. 38944)
Irena Lager	(Reg. No. 39260)
Frederick B. Luludis	(Reg. No. 26299)
Christopher N. Malvone	(Reg. No. 34866)
Scott W. McLellan	(Reg. No. 30776)
Geraldine Monteleone	(Reg. No. 40097)
John C. Moran	(Reg. No. 30782)
Michael A. Morra	(Reg. No. 28973)
Gregory J. Murgia	(Reg. No. 41209)
Claude R. Narcisse	(Reg. No. 38979)
Joseph J. Opalach	(Reg. No. 36229)
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Jack R. Penrod	(Reg. No. 31864)
Daniel J. Piotrowski	(Reg. No. P-42079)
Gregory C. Ranieri	(Reg. No. 29695)
John T. Rehberg	(Reg. No. 29207)
Scott J. Rittman	(Reg. No. 39010)
Eugene J. Rosenthal	(Reg. No. 36658)
Bruce S. Schneider	(Reg. No. 27949)
Ronald D. Slusky	(Reg. No. 26585)
David L. Smith	(Reg. No. 30592)
Patricia A. Verlangieri	(Reg. No. P-42201)
John P. Veschi	(Reg. No. 39058)
David Volejnicek	(Reg. No. 29355)
Charles L. Warren	(Reg. No. 27407)
Eli Weiss	(Reg. No. 17765)

BAYS (770)

Please address all correspondence to FARKAS & MANELLI PLLC, 2000 M Street, N.W. 7<sup>th</sup> Floor, Washington, DC 20036-3307, and all telephone calls to William H. Bollman at (202) 261-1020.

Full name of 1<sup>st</sup> joint inventor: **Laurence Edward Bays**

Inventor's signature Laurence Edward Bays Date: 6/24/98

Residence: **Allentown, Lehigh County, Pennsylvania**

Citizenship: **USA**

Post Office Address: **2821 Hampton Court, Allentown, Pennsylvania 18103**

Full name of 2<sup>nd</sup> joint inventor: **Jalil Fadavi-Ardekani**

Inventor's signature \_\_\_\_\_ Date: \_\_\_\_\_

Residence: **Orefield, Lehigh County, Pennsylvania**

Citizenship: **USA**

Post Office Address: **5530 Heather Lane, Orefield, Pennsylvania 18069**

Full name of 3<sup>rd</sup> joint inventor: **Srinivasa Gutta**

Inventor's signature \_\_\_\_\_ Date: \_\_\_\_\_

Residence: **Allentown, Lehigh County, Pennsylvania**

Citizenship: **INDIA**

Post Office Address: **2429 Allenbrook Drive, Allentown, Pennsylvania 18103**

BAYS (770)

Please address all correspondence to FARKAS & MANELLI PLLC, 2000 M Street, N.W. 7<sup>th</sup> Floor, Washington, DC 20036-3307, and all telephone calls to William H. Bollman at (202) 261-1020.

Full name of 1<sup>st</sup> joint inventor: Laurence Edward Bays

Inventor's signature \_\_\_\_\_ Date: \_\_\_\_\_

Residence: Allentown, Lehigh County, Pennsylvania

Citizenship: USA

Post Office Address: 2821 Hampton Court, Allentown, Pennsylvania 18103

Full name of 2<sup>nd</sup> joint inventor: Jallil Fadavi-Ardakani

Inventor's signature Jallil Fadavi-Ardakani Date: June 26, 1998

Residence: Orefield, Lehigh County, Pennsylvania

Citizenship: USA

Post Office Address: 5530 Heather Lane, Orefield, Pennsylvania 18069

Full name of 3<sup>rd</sup> joint inventor: Srinivasa Gutta

Inventor's signature \_\_\_\_\_ Date: \_\_\_\_\_

Residence: Allentown, Lehigh County, Pennsylvania

Citizenship: INDIA

Post Office Address: 2429 Allenbrook Drive, Allentown, Pennsylvania 18103

**BAYS (770)**

Please address all correspondence to FARKAS & MANELLI PLLC, 2000 M Street, N.W. 7<sup>th</sup> Floor, Washington, DC 20036-3307, and all telephone calls to William H. Bollman at (202) 261-1020.

Full name of 1<sup>st</sup> joint inventor: **Laurence Edward Bays**

Inventor's signature \_\_\_\_\_ Date: \_\_\_\_\_

Residence: **Allentown, Lehigh County, Pennsylvania**

Citizenship: **USA**

Post Office Address: **2821 Hampton Court, Allentown, Pennsylvania 18103**

Full name of 2<sup>nd</sup> joint inventor: **Jalil Fadavi-Ardekani**

Inventor's signature \_\_\_\_\_ Date: \_\_\_\_\_

Residence: **Orefield, Lehigh County, Pennsylvania**

Citizenship: **USA**

Post Office Address: **5530 Heather Lane, Orefield, Pennsylvania 18069**

Full name of 3<sup>rd</sup> joint inventor: **Srinivasa Gutta**

Inventor's signature Srinivasa Gutta Date: 6/24/98

Residence: **Allentown, Lehigh County, Pennsylvania**

Citizenship: **INDIA**

Post Office Address: **2429 Allenbrook Drive, Allentown, Pennsylvania 18103**

BAYS (770)

Full name of 4<sup>th</sup> joint inventor: **Bahram Ghaffarzadeh Kermani**

Inventor's signature B. Gh. Kermani Date: 6/24/98

Residence: **Whitehall, Lehigh County, Pennsylvania**

Citizenship: **IRAN**

Post Office Address: **1346 North 14<sup>th</sup> Street, Apt. R20, Whitehall, Pennsylvania 18052**

Full name of 5<sup>th</sup> joint inventor: **Richard Joseph Niescier**

Inventor's signature Richard Niescier Date: 6/24/98

Residence: **Bethlehem, Northampton County, Pennsylvania**

Citizenship: **USA**

Post Office Address: **1937 Peach Tree Lane, Bethlehem, Pennsylvania 18015**

Full name of 6<sup>th</sup> joint inventor: **Geoffrey Lawrence Smith**

Inventor's signature \_\_\_\_\_ Date: \_\_\_\_\_

Residence: **Tinton Falls, Monmouth County, New Jersey**

Citizenship: **USA**

Post Office Address: **39 Society Hill Way, Tinton Falls, New Jersey 07724**

**BAYS (770)**

Full name of 4<sup>th</sup> joint inventor: **Bahram Ghaffarzadeh Kermani**

Inventor's signature \_\_\_\_\_ Date: \_\_\_\_\_

Residence: **Whitehall, Lehigh County, Pennsylvania**

Citizenship: **IRAN**

Post Office Address: **1346 North 14<sup>th</sup> Street, Apt. R20, Whitehall, Pennsylvania 18052**

Full name of 5<sup>th</sup> joint inventor: **Richard Joseph Niescier**

Inventor's signature \_\_\_\_\_ Date: \_\_\_\_\_

Residence: **Bethlehem, Northampton County, Pennsylvania**

Citizenship: **USA**

Post Office Address: **1937 Peach Tree Lane, Bethlehem, Pennsylvania 18015**

Full name of 6<sup>th</sup> joint inventor: **Geoffrey Lawrence Smith**

Inventor's signature *Geoffrey Smith* Date: *7/7/98*

Residence: **Tinton Falls, Monmouth County, New Jersey**

Citizenship: **USA**

Post Office Address: **39 Society Hill Way, Tinton Falls, New Jersey 07724**

-5-

**BAYS (770)**Full name of 7<sup>th</sup> joint inventor: **Walter G. Soto**Inventor's signature Walter Soto Date: Jan 24, 98Residence: **Irvine, Orange County, California**Citizenship: **USA**Post Office Address: **20 LaRonda, Irvine, California 92714**Full name of 8<sup>th</sup> joint inventor: **Daniel K. Greenwood**

Inventor's signature \_\_\_\_\_ Date: \_\_\_\_\_

Residence: **Red Bank, Monmouth County, New Jersey**Citizenship: **USA**Post Office Address: **480 Worthley Street, Red Bank, New Jersey 07701**

-5-

BAYS (770)

Full name of 7<sup>th</sup> joint inventor: **Walter G. Soto**

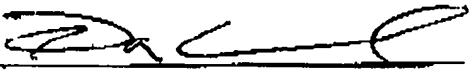
Inventor's signature \_\_\_\_\_ Date: \_\_\_\_\_

Residence: **Irvine, Orange County, California**

Citizenship: **USA**

Post Office Address: **20 LaRonda, Irvine, California 92714**

Full name of 8<sup>th</sup> joint inventor: **Daniel K. Greenwood**

Inventor's signature  Date: 7/8/98

Residence: **Red Bank, Monmouth County, New Jersey**

Citizenship: **USA**

Post Office Address: **480 Worthley Street, Red Bank, New Jersey 07701**

**40**